

FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of)	
)	
Promoting More Efficient Use of Spectrum)	ET Docket No. 10-237
Through Dynamic Spectrum Use Technologies)	

COMMENTS OF THE TDK R&D CORPORATION ON NOTICE OF INQUIRY

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1. INTRODUCTION

TDK R&D Corporation (“TDK R&D”) is grateful to the Commission for providing the opportunity through the Notice of Inquiry¹ on dynamic spectrum access (“DSA”) to comment on ways to more effectively and expeditiously implement DSA. Japan-based TDK Corporation (“TDK”) has been in the electronics business for over 75 years and is a global manufacturer of passive electronic components, modules and systems. TDK established its first US operation more than 50 years ago, and since that time has significantly increased its US presence. TDK R&D is a wholly owned subsidiary of TDK U.S.A. Corporation, which is, in turn, owned by TDK. TDK R&D engages in the development of components and systems in support of emerging technologies and applications on behalf of TDK. In addition to TDK R&D, TDK has design centers in California, Michigan, New Jersey and Texas, manufacturing facilities in California, Georgia and Oklahoma and numerous sales offices located throughout the US. TDK’s combined workforce in the US is over 1400 people.

2. EXECUTIVE SUMMARY

The National Broadband Plan published last year lays out the requirements and new potential uses for additional spectrum as well numerous recommendations to meet those needs. A recent FCC Staff report on Mobile Broadband has highlighted the urgency of those

¹ Promoting More Efficient Use of Spectrum through Dynamic Spectrum Use Technologies, Notice of Inquiry, ET Docket No. 10-237, 25 FCC Rcd 13711 (Nov. 30, 2010) (“DSA NOI”).

spectrum needs.^{2,3} While spectrum shortages are being forecast for the future, the effects can already be observed with emerging telehealth technologies and also advanced metering infrastructure (“AMI”) for Smart Grid (“SG”) rollouts. The DSA NOI has requested information and comment on a variety of DSA related technologies and these comments specifically address the topic of Test-Beds for Developmental Purposes.⁴

Current test-beds for dynamic spectrum access (DSA) radios are generally open-air facilities operating with just a few different models of software defined radios (SDRs) as cognitive nodes. The facilities typically have FCC experimental licenses that cover a narrow range of frequencies for the given geographical location of the facility. These facilities lend themselves well to testing application through media access control (MAC) layer innovations and overall modulation schemes and networking protocols as well as providing virtual access to the test-bed. The establishment of a complementary facility for testing devices in an anechoic chamber would allow for utilization of any spectrum of interest since the RF signals would be contained within the chamber. In addition, a key discussion point has been propagation of both opportunistic and incumbent signals and a chamber would allow for investigation of near and far field interference. Establishing this facility as a joint government / industry / academia venture would provide all stakeholders with access, enabling further innovation and

² Connecting America: The National Broadband Plan, Federal Communications Commission, March 2010 (“BB Plan”).

³ “Mobile Broadband: The Benefits of Additional Spectrum”, FCC Staff Technical Paper, Oct. 2010.

⁴ DSA NOI at ¶ 47

collaboration. The potential utilization of such a facility would benefit numerous application areas, both within and beyond the scope of the DSA NOI.

3. BACKGROUND

The concept of electromagnetic (EM) test-beds, or laboratories, has been around since at least the 1600's when early electric and magnetic pioneers began studying various electromagnetic phenomena in earnest. Perhaps the most legendary of these EM test-beds was Benjamin Franklin's back yard where in the mid 1700's he reportedly flew his kite. Even in those early days scientists understood the importance of controlling the environment where experiments were conducted and the need to exclude, to the largest extent possible, outside influences that could impact experiment results. There are several modern day methods used to control electromagnetic environments. They range from simply monitoring background levels in the environment and removing these from measurements, to performing measurements in Faraday cages, all the way to isolation in fully lined anechoic chambers.

Understanding the characteristics of various EM waves and the interactions between them and objects as well as the characteristics of the equipment used to generate, receive and measure those waves is becoming increasingly important as the number of transmitters continues to expand. This has led to difficulty in finding sufficient spectrum for all desired uses in the right frequency ranges of interest to allow for uninterrupted transmission links. This difficulty has led to the development of novel transmission (e.g. frequency hopping, and ultra

wideband or UWB) and modulation (e.g. OFDM) schemes to better utilize the available spectrum.

4. CURRENT TEST-BEDS

A more recent development in transmission schemes has been the implementation of dynamic spectrum access (“DSA”) in the unused portions of the television broadcast bands that are authorized by the FCC.⁵ In order to better understand DSA and cognitive radio (“CR”) operation, function and networking, test-beds have been established that generally emphasize the implementation of a large number of transceivers, usually accomplished by utilizing software defined radios (SDRs).⁶ The number of readily available models of SDRs is still somewhat limited so that there is generally not much variation in hardware both within and between test-beds.

The NTIA has established a test-bed to look more at the available hardware and investigate the interaction of Federal and non-Federal signals in an effort to understand points of coexistence where spectrum may be shared.⁷ In 2008 the NTIA offered to test industry DSA radios and numerous companies volunteered.⁸ That effort is on-going.⁹

⁵ 47 CFR Part 15 Subpart H

⁶ Some examples are summarized in Advances in Standards and Test-beds for Cognitive Radio Networks; Part I, IEEE Communications Magazine, September 2010

⁷ The President’s Spectrum Policy Initiative Spectrum Sharing Innovation Test-Bed, Notice of Inquiry, National Telecommunications and Information Administration (“NTIA”), Docket No. 060602142-6142-01,

⁸ Spectrum Sharing Innovation-Test-bed, Notice of Solicitation of Participation, NTIA, Docket No. 080129095–8096–01, February 5, 2008.

Although the DSA radio and networking characterization can be accomplished in a wired mode,¹⁰ the test-beds are generally wireless. A key concern by all involved with these facilities is that incumbent users, and in particular public safety, not be affected by the operations of the test-beds. To this end the FCC grants experimental licenses that involve narrow slices of spectrum depending on what is available in the geographic location of the test-bed.¹¹

The lack of variation in hardware and operation in a limited portion of the spectrum makes these facilities a very good place to experiment with the software in the application through media access control (MAC) layers to investigate fundamental characteristics of new modulation and networking techniques while allowing for virtual access in remote areas. Since the amount of spectrum examined is very limited, however, while the results of experiments are informative, they are difficult to scale due to numerous factors such as the limited architectural approaches, propagation characteristics of the waves within the allocated bandwidth and the lack of variation with regards to general physical operating environment.

There is also the problem that new radios utilizing these test-beds must be frequency converted to the frequency allowed for that particular site. While this is not an insurmountable problem it limits participants to those with sufficient engineering resources to accomplish the

⁹ Examination of Dynamic Spectrum Access Sharing Techniques, E. Drocella, 2010 International Symposium on Advanced Radio Technologies ("2010 ISART"), July 27 – 30, 2010.

¹⁰ Dynamic Spectrum Access Cognitive Radio Testbed, K. A. Grove, J. O'Connor, C. R. Anderson, Virginia Tech 2010 Wireless Symposium and Summer School, June 2 – 4, 2010.

¹¹ 47 CFR Part 5

conversion while also placing limitations on novel transmission schemes such as frequency hopping and UWB.

These limitations restrict the ability of existing test facilities to fully characterize innovation in the architecture and frequency agility of the hardware. A question in the DSA NOI is whether “scraps” of spectrum can be sewn together to make a useful piece of spectrum.¹² As pointed out in the NOI, there are certainly physical limitations in hardware that may make this difficult with technology available today, but future innovation may well potentially remove these barriers.¹³ From an experimental viewpoint, however, it would be ideal if the entire spectrum of interest for any particular system could be accessed to better understand the effects on incumbent systems.

5. ANECHOIC CHAMBER TEST-BEDS

One way to overcome the limited spectrum available at existing test-beds would be to utilize an anechoic chamber. While these chambers are often thought to be the ideal way to keep devices under test free from undesired EM radiation, they also act to keep radiation generated by the tested devices confined so that there is no threat to incumbents.¹⁴ Moreover, antennas can be located in specific locations and signals either generated or reproduced to take into account fading and other propagation effects.

¹² DSA NOI at ¶ 45

¹³ Ibid.

¹⁴ See IEEE-STD 299 & MIL STD 220 for shielding and attenuation measurement and characteristics.

In specific response to the DSA NOI request on test-beds, TDK R&D believes that the establishment of a Center for Open in-Anechoic Chamber Testing (“COACT”) as a joint effort of industry, government, and academia, would complement existing facilities by allowing for the undertaking of increasingly critical kinds of experimentation that is not permitted at other facilities.¹⁵ The facility should be governed in a way that allows access to all stakeholders (incumbents, researchers, innovators, and industry) and managed so that collaboration of all stakeholders is encouraged.

With regard to the DSA NOI COACT would enable and promote the innovation and experimentation required to allow more intensive and efficient use of the radio spectrum while allowing development of more effective management techniques of the spectrum. Such a test-bed would facilitate the advancement of knowledge regarding many portions of the DSA NOI, namely:

- Demonstrating that dynamic access radios function as intended under actual usage conditions.¹⁶
- Enabling testing of radio spectrum sensing and providing a meeting place for hardware and software developers, regulators and incumbents to demonstrate the strengths and weaknesses of various implementations on near real conditions.¹⁷
- Providing a facility to test sensors against EM environmental variations to permit determination of sensing thresholds in various bands over varying conditions.¹⁸

¹⁵ DSA NOI at ¶

¹⁶ Id. at ¶ 18

¹⁷ Id. at ¶ 20

¹⁸ Id. at ¶¶ 21 & 50

- Permitting research to be done on interference detection since the noise floor and background noise and / or other temporal fluctuations can be carefully adjusted.¹⁹
- Permitting research and evaluation for interference suppression techniques. Providing for evaluation of innovative architectural approaches that can be readily compared to existing approaches, and the trade-offs between interference suppression and interference avoidance can be identified.²⁰
- Permitting the measurement of near and far field propagation that can be compared to models, hence adding to the existing knowledge base. Objects can be placed and moved within a chamber to determine the effects of absorption and reflection. These measurements combined with longer range open air measurements could potentially yield better application of existing models or the development of new ones.²¹

There are also numerous other potential applications for a COACT. One example is that the BB Plan recommends that the FCC open up more unlicensed spectrum.²² A COACT test-bed could potentially provide the FCC with the opportunity to evaluate options on how and where to open up that spectrum. The facility could schedule numerous “unplug fests” that focus on different aspects of spectrum utilization allowing the FCC and all stakeholders to try out new ideas and find strengths and weaknesses of different approaches. For example, a piece of spectrum could be designated for consideration for unlicensed use under the control of a beacon, such as NIST’s WWV. Working with industry and academia through the COACT, an advance announcement could be made of a proposed scope and purpose of a novel spectrum management technique and a request for particular proposed equipment. This could be

¹⁹ Id. at ¶ 23

²⁰ Id. at ¶ 25

²¹ Id. at ¶¶ 26 & 27

²² BB Plan Recommendation 5.11.

accomplished in much the same administrative way that the FCC functions today, with the issuance of a public notice that experiments or trials would be undertaken at the COACT in order to determine their effectiveness. After public comment periods and open discussion between stakeholders through workshops, the idea could be refined, a final notice issued, and a date set when stakeholders could have equipment ready. A similar process could be set up for any stakeholder to make proposals and garner interest for different ideas.

While the responsibility of establishing a test-bed to enable innovation in areas other than DSA are beyond the scope of the DSA NOI, the establishment of a COACT would facilitate other applications, such as Smart Grid (“SG”) communications and telehealth, that are of interest to numerous Federal agencies.²³

The SG is essentially today’s grid with the enhanced features of information technology, communication technology and automation surrounding and controlling it. One element of the communications dimension is the utilization of smart meters in Advanced Metering Infrastructure (“AMI”) to permit communication between the point-of-use and the utility. There have been some well publicized, and some not as well publicized, issues seen with the roll out of some AMI initiatives, including problems between wireless smart meters and the network.^{24,25} While some of these problems have been rectified, others are still being addressed. Although NIST is leading the interoperability effort, there has been discussion

²³ BB Plan Recommendations 10.3, 12.1, 12.4, 12.5, 12.6,

²⁴ PG&E Acknowledges Smart Meter Problem, KGO TV San Francisco, CA, April 26, 2010.

²⁵ Texas Utilities Admit Billing Errors with SmartMeters, KGO TV San Francisco, CA, April 14, 2010.

suggesting that DSA could be part of the solution to this problem.^{26,27} Having a test-bed that is capable of trying out different ideas and systems would allow confirmation or modification of these ideas and suggestions.

Another aspect of SG interoperability and reliability is electromagnetic compatibility (“EMC”) and RF coexistence of SG equipment. A facility to test out various pieces of equipment with regard to various environmental factors would be extremely useful in the establishment of the interoperability standards. Perhaps one of the greatest threats to the country today comes from electromagnetic pulse (“EMP”) events from any number of sources. The need for the grid to be hardened against these events would be greatly enhanced with a COACT in place to permit the evaluation of equipment immunity to these threats.

At the joint FCC / FDA medical device workshop last year there was significant discussion on the effects of signal interference, particularly in the unlicensed bands, in both hospital and residential settings.²⁸ While there were numerous ideas as well as discussion on dedicated spectrum, several of the speakers mentioned that having a test-bed available to them would be useful in developing innovative products.²⁹

²⁶ Nation’s First “Smart Grid” White Spaces Network Trial, Spectrum Bridge Press Release, June 23, 2010.

²⁷ Low Cost and Secure Smart Meter Communications Using the TV White Spaces, O. Fatemieh, R. Chandra, and C. A. Gunter, IEEE International Symposium on Resilient Control Systems (ISRCS ’10), August 2010.

²⁸ Enabling the Convergence of Communications and Medical Systems, FCC/FDA Joint Meeting on Life Saving Wireless Medical Technology, July 26 – 27, 2010.

²⁹ Enabling the Convergence of Communications and Medical Systems, FCC/FDA Joint Meeting on Life Saving Wireless Medical Technology Transcript, Day 1 and 2, July 26 - 27, 2010.

6. CONCLUSION

There are numerous CR and DSA test-beds set up across the United States and globally, but for the most part these are open-air sites that operate on very narrow slices of spectrum so as not to interfere with operating services. In general, these test-beds utilize generally similar radios to examine the effect of signal integrity and coexistence in the presence of a large number of either identical or non-compatible signals. This limited amount of spectrum and hardware imposes restrictions on the ability to fully evaluate DSA. A facility should be established that removes these limitations. A suitably designed and constructed anechoic chamber would do just that.

A key aim of the DSA NOI is to obtain information on how spectrum can be better shared among users. It is anticipated that the FCC will receive new ideas and information from a wide variety of sources and it will likely be difficult to balance the merits of these new ideas against the needs of incumbents. Access to an anechoic chamber facility where near real world conditions are established would allow for the open determination of the actual technical merits and issues regarding coexistence and interference of new technologies with those of existing services provided by incumbents.